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Agricultural Research

Public Responsibilities of the Scientist

Dr. Anson R. Bertrand
Director of Science and Education

We have a big gap in public perception of agricultural research, extension, and teaching and what they mean to this country. As scientists and educators we must take the responsibility for closing that gap. We need to build bridges, and the building of these bridges is the subject of this paper.

As first a scientist, and second as a science manager, there are five responsibilities I would like to discuss:

First, we have a responsibility to know, or to *learn* if we don't already know, how the public views science today. What do they think of us? What concerns and troubles them? We must have this perspective, and we must keep it firmly in mind, if we are to help . . . Maybe even be *allowed* to help . . . set the Nation's agenda.

Second, we have to concern ourselves with the consequences of our work. If we have learned anything in recent years, it is that technological solutions are unlikely to be permanent or complete solutions. We worked hard to find solutions to problems which limit production—pests, diseases, genetic limitations, climatic stresses, labor shortages—only to find many of our answers competing in new arenas against new or different sets of values.

Today, more than ever, each advance seems to generate new problems as it solves old ones. Few advances are adequate enough to ensure enhanced social welfare without question. We know that any time science provides us with new ability to determine traces of a substance where we could detect no trace before, then we are committed to a much, much larger view of that substance than we might ever have considered before.

Third, scientists and educators have a real responsibility as members of a partnership to help keep alive the "scientific soul" of their administrators. It is the working scientist who sees first-hand the day-to-day needs of science. It is the working scientist who suffers from the bureaucratic bottlenecks that threaten scientific opportunities.

At the same time, it is all too easy for a science administrator to become inundated with matters that may not directly concern science. The working scientist must take a share of the responsibility to communicate, so that the needs and priorities and opportunities of science are correctly perceived.

We have a convincing story to tell in terms of what would happen if chemists and agronomists stopped their war on weeds. Or the dramatic effects on water supplies if soil erosion is permitted to go unchecked.

Scientists should seize every opportunity they can to provide managers with information that can help them do a more effective job of securing and husbanding the resources to support truly important scientific efforts. What kind of information do science administrators need? They need the kind of information that can help them in policy and decisionmaking processes. They need the kind of information that forms the basis for the **fourth** responsibility—the responsibility to participate fully in the shaping of public opinion.

We must translate our work into meaningful terms and objectives for all of our publics. For example, budget analysts frequently examine specific projects. It might not be obvious unless we state clearly, that our work on nitrogen fixation has direct application to energy conservation. We must make it understood that if we can produce changes in soil bacteria or in the host plants such as corn, wheat, and rice, so that these plants will be able to produce a significant part of their own nitrogen requirements, this would be of enormous importance to this country in reducing that portion of our petroleum imports now devoted to synthetic nitrogen production. Here is where one of our highest priority projects in food production needs to be translated, so that it can be understood not only for its scientific merit, but for its contribution to national goals of the highest importance.

We aren't going to have these answers tomorrow. It will take a lot of time and effort. But the future of our food supply depends upon a public opinion that sees the wisdom of an investment in such basic research aimed at discovering fundamental mechanisms in biological processes.

That brings me to the **fifth** responsibility that I believe we as scientists and educators must accept, and that is the responsibility to fight for science itself . . . for its place in society . . . for its contributions to society . . . for its right to be heard and its need to be nourished by society.

All of these responsibilities can be summed up in this way: Have we been honest and competent in setting our goals and objectives? We must ask ourselves: Do they speak to the good of all the people? What needs do they meet? What concerns do they address? Are we talking in language that can be understood? Are we believable? Are we overstating the case? Are our arguments persuasive as well as accurate? Have we marshalled the data we need? Are we talking to the proper audiences with appropriate messages? Are we making the extra efforts that may be required of us in order to insure rational, honest decisionmaking?

I intend to use these questions as guides in making the strongest possible case for food and agricultural research, extension, and teaching. I invite you to join me in this effort.

*Excerpts from remarks by Dr. Anson R. Bertrand, at the 71st annual meeting of the American Society of Agronomy, Fort Collins, Colorado.

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Illustrations for Crops, Marketing, Plant Science, and Agrisearch Notes: p.2 Tree; p.123 Broccoli; p.211 "The Bonnet"; p.294 "Experiments in Water-culture" in *Food Gardens* by Tom Riker and Harvey Rottenberg. Copyright © 1975 by Tom Riker and Harvey Rottenberg. By permission of William Morrow & Company.

Photos on pp. 14 and 15 courtesy Grant Heilman. Photo p. 12 courtesy Photo Researchers, Inc.

Cover: Grasshoppers — so small yet so destructive — are the subject of a biological control program developed by entomologists at the SEA Rangeland Insect Laboratory in Bozeman, Montana (0779X981-18A).

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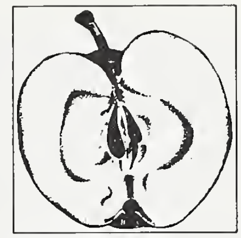

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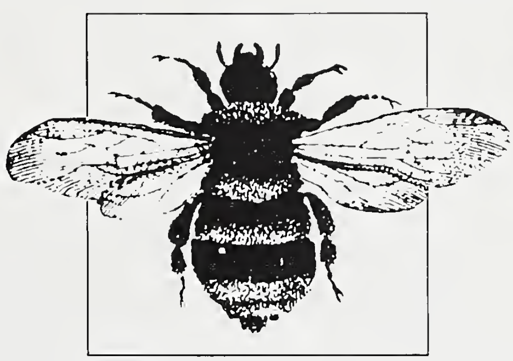

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Controlling Grasshoppers— Manna from Montana

In 1875, people throughout the Rockies and as far east as Michigan lived beneath the sinister shadows cast by billions of grasshoppers in swarms so thick they eclipsed the sun. Flights of hoppers 100 miles long, 3 miles high, and 15 miles wide were reported and the insects ate everything from crops to fences to shovel handles. Of all the world's insect pests, none are more destructive than grasshoppers.

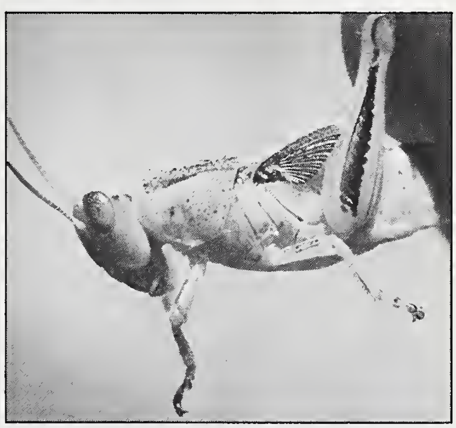
Grasshopper plagues have been a bane to humanity throughout history. Famine and pestilence travel in their far-flung wake. Even today, India and many of the poorer, developing countries in Africa suffer devastating grasshopper attacks each year. In the past two summers, parts of the United States have also been hit hard.

For the past 25 years or so, insecticides such as malathion or carbaryl have been the main means of control. But, insecticides are costly and, because of grasshopper migration habits, often impractical to use. Furthermore, the possibility of grasshoppers developing genetic resistance to insecticides always exists.

Biological Control

Biological control offers the safest, most economical means of holding grasshopper populations down to levels the environment can tolerate. This is all that is needed for it's only when hopper populations become too dense that the insects swarm and migrate and cause enormous damage to crops.

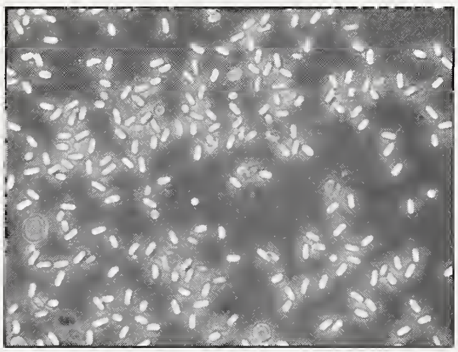
Pioneers in biological control of grasshoppers are the SEA researchers at the Rangeland Insect Laboratory, Bozeman, Mont. Led by entomologists John H. Henry and Jerome A. Onsager, the research team in 1975 found a way of infecting grasshoppers on a mass scale with a deadly, naturally occurring hopper disease called *Nosema locustae,* which roughly translates to "grasshopper sickness."



Opposite: Nebraska pioneer Swain Finch recreates for 1890's photographer Solomon Butcher his futile fight against grasshoppers during the plague of 1876. Finch described to Butcher the "wall of grasshoppers" that "left his fields brown and bare, as if swept by fire." (Photo courtesy Solomon D. Butcher Collection, Nebraska State Historical Society-B983-2156H).

Above: At the turn of the century, Montana ranchers banded together to fight their most persistent and costly insect pest — the grasshopper. Canvas wagon covers were used to mix bran with lead arsenate, a poison long since outlawed. (Photo courtesy National Archives-C&F 5952).

Left: This laboratory infected grasshopper, *Melanoplus bivittatus,* will produce enough disease spores to cover 3 to 4 acres of "hopper" infested land (0679X791-25).



Above: Easy Rider: Jerry Onsager cycles around test plots placing rings used for counting the number of grasshoppers in specified areas (0779X988-15A).

Right: Techniques used by John Henry for mass grasshopper infection are being tested to bring severe outbreaks under control (0679X797-36A)

Lower right: These *Nosema locustae* spores, magnified 900 times, are at the stage where they can be used for infecting grasshoppers (0679X801-3).

Already, several severe grasshopper outbreaks since then have been brought under control by spraying *Nosema locustae* spores onto wheat bran, then dropping the wheat bran into infested areas.

Grasshoppers eat the *Nosema locustae*-coated bran, contract the disease and die. Other hoppers eat the cadavers of their comrades and also contract the disease and die. One application of this deadly manna may provide grasshopper control for up to 10 years.

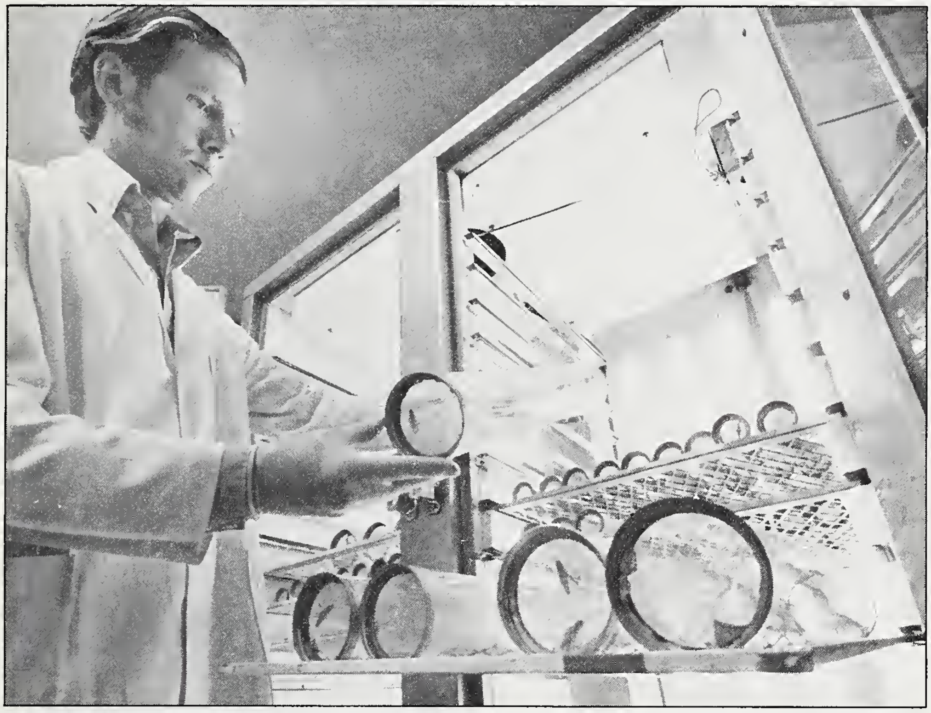
Affecting only grasshoppers and the also destructive mormon cricket, *Nosema locustae* poses no threat to people, plants, or animals. Beekeepers did become alarmed when they first heard of the disease because its name is so similar to *Nosema apis,* a harmful honey bee parasite. However, SEA entomologist William T. Wilson, Laramie, Wyo., tested *Nosema locustae* on honey bees and found no effect.

Besides being safer than insecticides, *Nosema locustae* does not build a resistance level in grasshoppers, lasts longer, and is much cheaper to use. Unfortunately, *Nosema locustae* requires about 2 weeks to take effect which is too much time for growers under seige.

There are two other grasshopper pathogens that are similar to *Nosema locustae* but which work much faster — *Nosema acridophagus* and *Nosema cuneatum.* The problem in developing these two pathogens as control methods has been finding a way to mass produce their spores in sufficient quantities for field testing.

Spore Production

Nosema locustae spores are produced in the laboratory by spraying a mass of lettuce with the pathogen, then feeding the lettuce to grasshoppers. About 99 percent of the grasshoppers fed contract the disease and these infected grasshoppers are then ground up, mixed with water, and aerosol-sprayed onto the wheat bran. One infected grasshopper will produce enough *Nosema locustae* spores to treat 2 acres of land.



Upper left: Lab technician Gerald Mussgnug places grasshoppers in the freezer to retain viable spores in their bodies for future use (0679X795-25A).

Left: Lab assistant Cheryl Gerdrum checks on grasshopper growth in the laboratory's rearing facility (0679X798-3).

Above: John Henry (foreground) and Gerald Mussgnug grind frozen grasshoppers, filter resulting mush, and concentrate *Nosema locustae* spores through a centrification process (0679X793-10A).

Corn Earworms

Nosema acridophagus and *cuneatum* kill infected grasshoppers too quickly for enough spores to be produced. Last year, Henry and Onsager found that the corn earworm, a notorious pest in its own right, can serve under laboratory conditions as an alternative host for the two "hotter" *Nosema* pathogens and produce more than enough disease spores for field testing.

Corn earworms are cheaper and easier to rear in a laboratory than grasshoppers and disease spores multiply faster in earworms. Corn earworms are innoculated as 4- to 6-day old larvae. The larvae are starved for a 24-hour period to upset their metabolism so that when they do eat, everything consumed will be absorbed.

A drop of distilled water containing disease spores is fed to the larvae and they are then starved a second time so that nothing interferes with their contracting the disease. At the end of this second starvation period, the corn earworms are placed in individual growth chambers. The spores multiply in the larvae until the disease kills the host — usually 2 to 3 weeks later.

Corn earworms can only be infected under laboratory conditions and only with *Nosema acridophagus* and *cuneatum,* not *locustae*. Right now, the process of innoculating earworms is time consuming and inefficient but the research team is working to correct this problem and progress is being made.

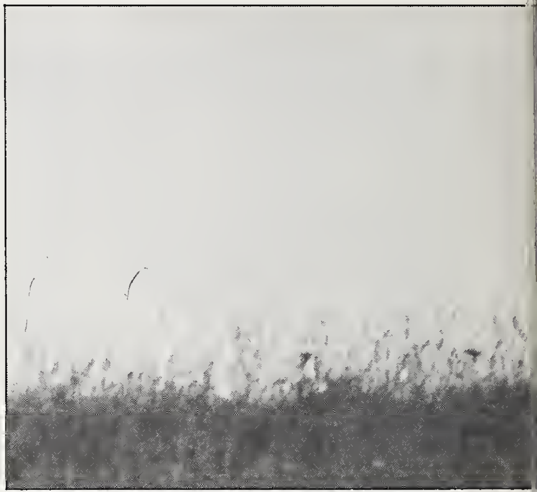
Until the two "hotter" *Nosema* pathogens are fully field-tested and ready for commercial use, *Nosema locustae* remains the best biological weapon against grasshopper plagues. The Rangeland Insect Laboratory team has found that the time needed to bring an outbreak under control can be considerably hastened by using *Nosema locustae* in combination with a small amount of insecticide.

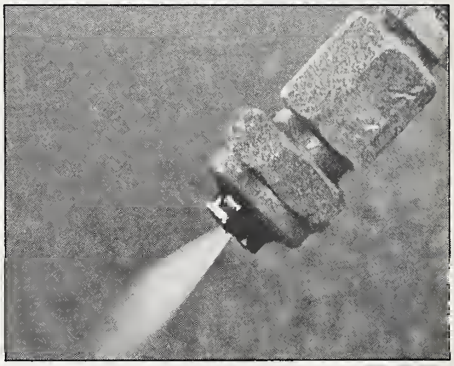
Using malathion or carbaryl in a bait formulation with *Nosema locustae* can reduce normal dosages of the chemicals by 94 to 98 percent, thereby reducing chemical treatment costs. Insécticide-treated bran is added to some of the pathogen-treated bran and both are then air-dropped over an infested area. Grasshoppers eating the chemical-treated bran die instantly which immediately reduces the infestation. Populations are then kept under control by the *Nosema locustae.*

Combined use of *Nosema locustae* and insecticide provides both immediate and long-term grasshopper control. Also, applying insecticides to only a portion of the treated wheat bran is a much more selective and environmentally safe use of chemicals than general broadcast applications. The combination of biological and chemical control should keep grasshoppers in line until the hotter pathogens are ready for market.

Carbaryl is currently registered by EPA for use in a bait formulation, but such use of malathion is still in experimental stages and has not yet received EPA approval.

Dr. Henry and Dr. Onsager are located at the Rangeland Insect Laboratory, Montana State University, South 11th Avenue, Bozeman, MT 59777. — (By Lynn Yarris, SEA, Oakland, Calif.)





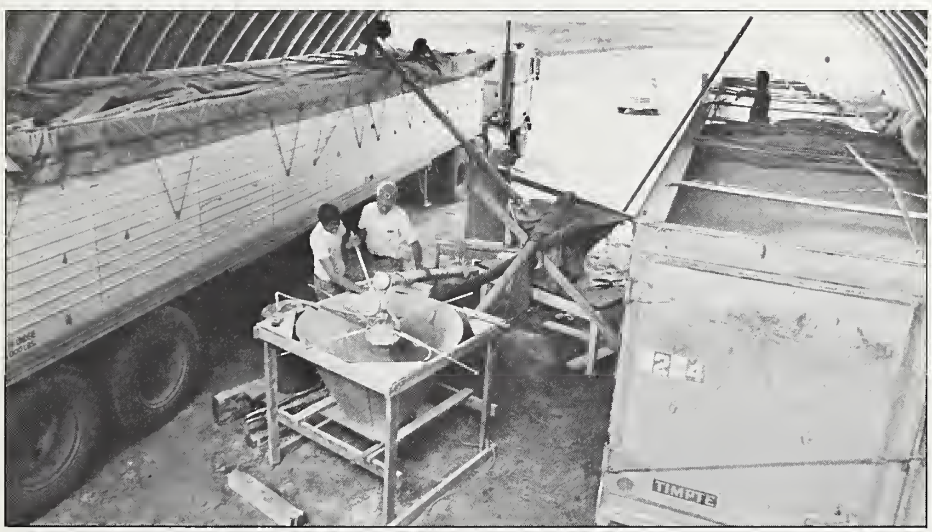
Top: Biological control from the air — grasshoppers do not build a resistance level to this long lasting, environmentally safe way of controlling their populations (0779X986-20A).

Above: Wheat bran sprayed with the naturally occurring grasshopper disease *Nosema locustae* poses no threat to people, plants, or animals (0779X994-25).

Lower right: Treated wheat bran is loaded from truck to bag to plane for aerial dispersal (0779X989-28).

Upper right: Two semi-loads of wheat bran are mixed with diseased spores at a ratio of 1 billion spores to each 1½ pounds of bran. The spore-bran bait is dispersed at a rate of 1½ pounds per acre (0779X982-4).

Far right: About 4 weeks after the bran is released, researcher Elaine Oma collects grasshoppers for lab analysis to see if they have contracted the disease (0779X984-29A).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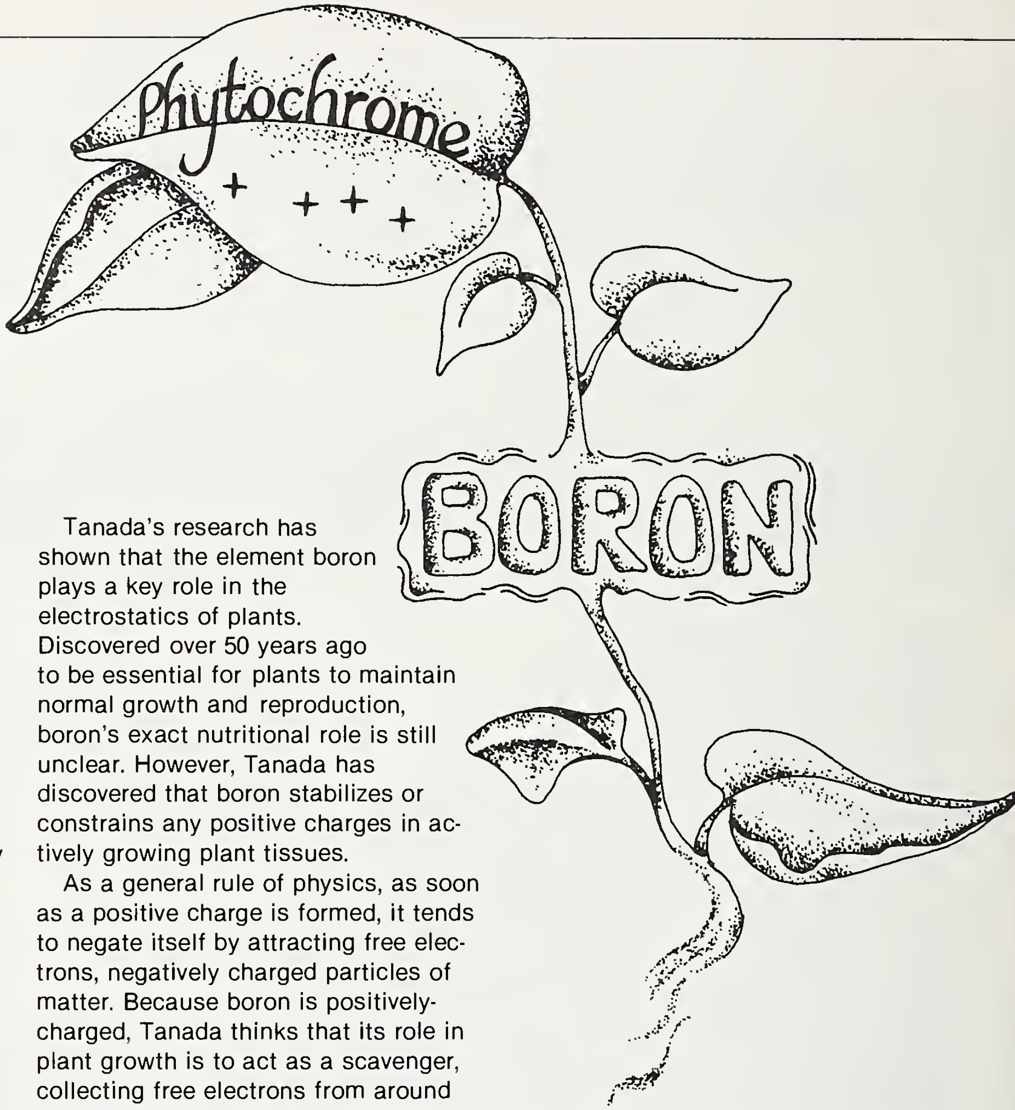
Electrostatics Charge Plants



Static electricity may be a prime force in plants. According to plant physiologist Takuma Tanada, subtle electrostatic charges could be intimately involved with how plants start and stop growing, why roots of healthy plants plunge inexorably toward the earth's center, or how seeds "know" when to germinate and send their shoots skyward.

Tanada, of SEA's Light and Plant Growth Laboratory at Beltsville, Md., has found that light and gravity, or both, induce positive electrostatic charges in the cell membranes of plants. The charges then probably set basic growth reactions in motion.

Scientists have theorized for some time that the forces that drive plant growth begin on the membranes, or thin skins, of cells, but basic mechanics have remained largely a mystery. "Light and gravity, of all environmental factors," says Tanada, "have been the most constant during the evolution of plant life. The fact that they are primary influences on growth is therefore not surprising. But, now we are learning how they operate."

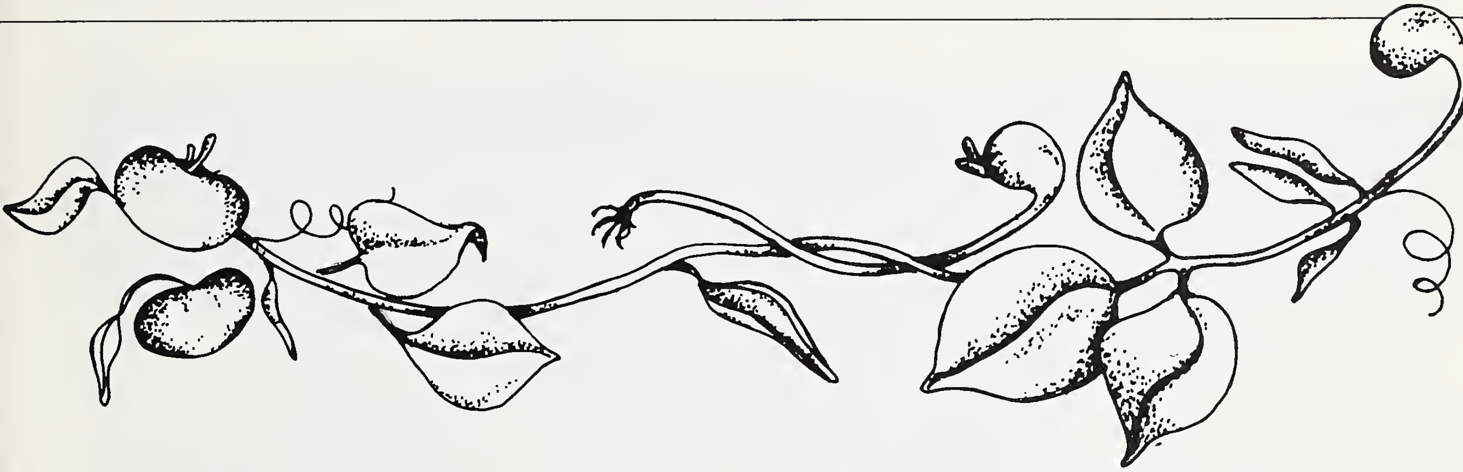
Tanada has proposed that the cell membrane acts as an electrical transducer. Transducers, in solid state physics, are devices that change electricity into other forms of energy. Telephone receivers, for example, change electrical current into sound. Tanada thinks that cell membranes in plants change positive electrostatic charges, created by light or gravity, into commands for various physiological actions. The membrane might use a positive charge to attract negatively-charged growth hormones in order to stimulate growth at a strategic location on a stem. Or, inhibiting compounds might be attracted in order to stop growth.

Tanada's research has shown that the element boron plays a key role in the electrostatics of plants. Discovered over 50 years ago to be essential for plants to maintain normal growth and reproduction, boron's exact nutritional role is still unclear. However, Tanada has discovered that boron stabilizes or constrains any positive charges in actively growing plant tissues.

As a general rule of physics, as soon as a positive charge is formed, it tends to negate itself by attracting free electrons, negatively charged particles of matter. Because boron is positively-charged, Tanada thinks that its role in plant growth is to act as a scavenger, collecting free electrons from around positive charges created in cell membranes, thus protecting charges from being cancelled out. A positive charge can then remain in effect long enough to get a growth process started.

After 25 years of innovative research with USDA, a period in which he has helped uncover many basic plant growth processes, Tanada says that his field of science has reached a point where important discoveries will come from the study of plant biophysics. "Plant physiologists tend to think mostly in terms of enzymes and growth hormones. We sometimes forget that plants obey certain physical laws as well as chemical and biological laws."

His work on electrostatics is related to a 1952 discovery (also by Beltsville scientists) of a light-sensitive pigment in plants called phytochrome. It was found that phytochrome directs the course of plant growth and development, depending on what quality or wavelengths of light the pigment receives. Tanada exposed sections of bean plant stems to those wavelengths most sensitive to phytochrome and found that phytochrome mediates or controls the creation of positive charges in growing tissue.



To show that the charges reside specifically on cell membranes, Tanada used clear logic, astute observation, and a $35 phonograph turntable. First, he dropped root tips of barley and bean plants (a root tip is actively growing tissue) into a glass of water. Then, he placed the glass on the turntable, slightly off center. At 33 revolutions per minute, the spinning motion should have kept the root tips suspended in the water. Instead, after Tanada exposed them to red light, the tips stuck to the glass. The light had created positive charges in the root tips. Glass is a negatively-charged material. The opposite charges attracted, and the tips stuck.

Root tips are composed mostly of liquid except for the orderly, crystal-like structures of the cell membranes. Because free charges cannot exist in a liquid medium, Tanada reasoned that they must be formed in the membranes.

During another experiment, while Tanada was "watching" charges created by light, he discovered that gravity also created positive charges in actively growing tissue. He had added a synthetic dye called fluorescein to bean plant stems. The dye is negatively-charged. Because it glows under special lighting, Tanada could measure the rate of its movement as positive charges pulled it along the stems. The test results, though, were inconsistent. Tanada found that the rate of fluorescein movement varied, depending on whether the bean stems were standing up or reclining. The rate was faster on the lower sides of the reclining stems than on the upper sides.

Tanada says the accumulated pressure of gravity on many cells created the positive charges in lower sides of reclining stems.

The charges, in turn, set growth processes in motion that began to reorient the stems into the proper direction, against the force of gravity. Presumably, says the scientist, the effect is the opposite on roots.

In a similar experiment on bean stems, Tanada found that the response of fluorescein movement to light or gravity was considerably lessened if the bean plants had been grown with abnormally low levels of boron. One need only look to the squash plant in order to illustrate how boron may stabilize the gravity-induced charges that initiate growth. When squash is grown in soil deficient in boron, the roots seem to lose their sense of direction. Instead of boring downward, they ramble along the surface of the soil.

Any practical, agronomic outcome from Tanada's studies of electrostatics in plants cannot be assessed at present. However, Gerald E. Carlson, chief of the Light and Plant Growth Lab, says that Tanada's work could have a tremendous impact on research, opening new doors for improving the control and management of food and feed production. His work is an integral part of one of the Lab's goals — developing crop plants that funnel more energy from light into those plant parts harvested for food and fiber.

"Everything that happens inside plants involves cell membranes," explains Carlson, "and all substances move through membranes sooner or later. Therefore any modification we would make to the fundamental workings of the membrane, as a result of Tanada's work, could have a multiplying effect on the growth and development patterns begun on the membranes. The research possibilities are endless."

Dr. Tanada's address is Bldg. 046A, BARC-West, Beltsville, MD 20705. (By Stephen M. Berberich, SEA, Beltsville, Md.)

A Clue in Brown Lung Cure

Scientists have found that cotton bracts, modified leaves at the bottom of the cotton boll, contain compounds which damage the normal defensive mechanisms of lungs.

This important clue may help scientists find the cause of byssinosis, commonly called "brown lung." Byssinosis, is a respiratory disease which affects cotton mill workers. Dust inhaled by the workers is the suspected cause of byssinosis. Precautions surrounding the use of human subjects has made it difficult for scientists to find the basic cause through human testing.

SEA microbiologist Richard L. Ziprin, working with plant physiologist Gerald A. Greenblatt, Texas Agricultural Experiment Station, found the clue to the problem by using cells from sheep lung cultures. They tested extracts from field-dried bracts on sheep lung cells, and found that the extracts inhibited normal cell response to the presence of foreign material.

Lungs possess a variety of defenses, one of which is an ability in certain inside lining cells to produce powerful oxidizing agents when the cells are contacted by foreign particles — and to render them harmless. This process was inhibited by the extracts of the cotton bracts.

The work was supported in part by funds from Cotton Incorporated, The Cotton Foundation, and the National Fibers and Food Protein Commission of Texas.

Dr. Ziprin is with the SEA Veterinary Toxicology and Entomology Research Laboratory, P.O. Drawer GE., College Station, TX 77840. Dr. Greenblatt is with the Texas Agricultural Experiment Station, also in College Station. — (By Bennett Carriere, SEA, New Orleans, La.)

Intercepting Roots

A SEA study has shown that a stand of sorghum-sundangrass roots did not allow nitrate-nitrogen to move below 30 inches of soil at a normal rate of application.

"Moreover, the roots intercepted both water and nitrogen and did not allow the nitrogen to leach below 40 inches of soil even when the fertilizer was applied at twice the normal rate," said soil scientist F. Leslie Long.

The information in this study will make a valuable contribution to the knowledge of non-point water pollution. Non-point water pollution is pollution that cannot be traced to a specific source. It is more difficult to learn about and control than pollution from a readily identifiable source.

Even at twice the normal rate of nitrogen application, the portions of mature plants above ground contained as much nitrogen as had been applied, Long added.

The study was conducted in 1978, with frequent samples of the soil solution taken at various depths for 132 days. Dr. Long's address is Room 230, Funchess Hall, Auburn University, Auburn, AL 36830. — (By Bennett Carriere, SEA, New Orleans, La.)

Roots—A Tool for Better Breeding

A breeder wants to develop a crop for a particular environment. What type of root system is needed to make the best use of available water? Should the plant have a deep or a shallow root system? A dense or sparse system? A root simulation model development by SEA researchers can provide these answers.

A plant can only carry on photosynthesis when it is not suffering from water stress (insufficient water uptake). Under water stress, plants shut down vital life cycle operations. By accurately predicting a plant's ability to extract water from the soil, researchers can assess whether or not that plant will suffer from water stress under any particular given environment.

Plant physiologist Betty Klepper and soil scientist Ronald W. Rickman, Pendleton, Ore., along with soil scientist Howard M. Taylor, Ames, Iowa, have designed a mathematical model that describes and predicts the water uptake and other functions of a plant's entire root system, as that system works in conjunction with the rest of the plant.

Unlike other models for predicting a plant's soil water extraction abilities, the SEA-developed model emphasizes root anatomies and allows researchers to get a total picture of all of the roots in a plant's system under field conditions. It not only shows breeders how much water roots can provide to the above-ground portion of the plant, it also shows which part of the root system collects the water.

This new model is based on a combination of such factors as root length, permeability of the roots, and the water extracting power or suction due to friction that occurs as water moves from the bottom of the roots to the top. With minor changes in values of these factors, it is universally applicable to all crops.

Klepper and her fellow researchers soon hope to tack a root growth model onto the front of their water uptake model and one day incorporate the entire equation into a model for nitrogen uptake. For now, the existing model is a great step towards understanding completely the functions and efficiency of a plant's root systems.

Dr. Klepper and Dr. Rickman are located at the Columbia Plateau Conservation Research Center, P.O. Box 370, Pendleton, OR 97801. Dr. Taylor is in Room 225, Agronomy Bldg., Iowa State University, Ames, IA 50011. — (By Lynn Yarris, SEA, Oakland, Calif.)

Ammonia Conserves Corn Feed Fuel

A new feed corn drying system, which replaces a flow of fuel with a trickle of ammonia, could save enough fuel in an average drying season to heat 100,000 central Illinois homes, says SEA microbiologist Rodney J. Bothast.

The process uses ammonia gas to keep corn from spoiling while it is drying in unheated or sun-heated air. It has been approved by the Environmental Protection Agency (EPA) for use on feed corn, Bothast says. This means that ammonia can be applied to corn by farmers or others who know that the corn will be used only for feed. Every year about a billion bushels of corn is fed on farms where it is produced.

In an average drying season, the trickle ammonia process with unheated air will use about 0.16 therms less energy per bushel of corn than high temperature drying uses.

"Assuming the process were used on a billion bushels of corn every year," Bothast says, "it could save enough energy to heat 100,000 homes with heating demands like those of the average gas company customer in central Illinois."

The process applies an intermittent trickle of ammonia gas, ½ pound to 1,000 pounds of corn, in the air flowing through the corn in a conventional drying bin. The EPA approval allows a maximum of 0.5 percent, or 5 pounds of ammonia in 1,000 pounds of corn.

The trickle of ammonia is enough to keep molds and other microorganisms from growing on the corn while it dries, Bothast says. Corn will dry in unheated air in 1 to 2 months, or faster if the air is warmed by the sun in one of the many solar systems farmers can use.

The system does not require expensive special equipment, but does require a conventional drying bin with a slotted floor and fan that blows 1 to

1½ cubic feet of air per minute per bushel, and a gas flow meter and garden hose to connect a conventional ammonia fertilizer tank to the fan plenum or hood. "Most corn farmers have all the equipment except the flow meter," Bothast says.

"The system controls toxigenic microorganisms, saves energy, minimizes corn quality deterioration and" as Bothast points out, "can operate over a wide range of weather conditions. It will be especially useful in areas or seasons with poor drying conditions at harvest time."

Dr. Bothast is one of a team of fermentation scientists and engineers who developed the ammonia process starting with basic studies in 1972 at the SEA Northern Regional Research Center, 1815 N. University, Peoria, IL. 61604. — (By Dean Mayberry, SEA, Peoria, Ill.)

Fresher Foods from Corn

Maintaining freshness of corn meal that goes into corn flakes, grits, tortillas, and animal feeds may become a greater problem for processors and consumers than it is today unless a trend in corn breeding is reversed, says SEA chemist Evelyn J. Weber.

Weber studies lipids or fat-like components of corn endosperm from which the meal is made. She says corn foods can become rancid quickly if they contain high amounts of polyunsaturated fatty acids. Portions of polyunsaturated acids are not fully loaded with hydrogen. These portions can combine with oxygen, causing the rancidity.

"Corn hybrids that breeders have developed over the past 15 years have tended to have more and more polyunsaturated fatty acid," said Weber. "This trend occurred inadvertently as the breeders focused their attention on improving yield and other agronomic qualities."

Scientists generally have focused their attention on corn germ or whole kernels when they have studied corn oil, lipids, and fatty acids. That's because more than four-fifths of the oil comes from germ. But Weber and her colleagues at the University of Illinois are also concerned about lipids in the endosperm which provides milling fractions for many foods.

Until now, researchers have had difficulty separating kernel parts — endosperm, germ, and pericarp — and getting the lipids out intact for chemical analyses. Weber found that boiling the corn in water for 2 minutes made the separation easy, and it inactivated enzymes that would break down the lipids. She then found most desirable techniques for extracting and analyzing the lipids.

Corn used in the experiments had a higher concentration of polyunsaturated fatty acids in lipids of the endosperm than in lipids of the germ. Weber also found that the endosperm contained 95 percent of the free fatty

acids, or fatty acids not incorporated into lipids or fats. Unsaturated free fatty acids are especially vulnerable to becoming rancid.

Finding the concentrations of various lipids and fatty acids in specific parts of kernels may give researchers clearer information than exists now on genetics of lipid production in corn, Weber says. The information may have practical significance in:

- germination of seed in cold or dry environments
- corn's resistance to insects
- industrial uses of fatty acids
- human and animal nutrition

Weber is confident that lipid compositions of endosperm and germ can be modified greatly by corn breeding. She points out that germ receives equal inheritance from both parents. Endosperm, however, gets two-thirds of its inherited characteristics from the female parent and only one-third from a male parent. With those considerations, breeders' selection of parents and decision as to which parent is used as the maternal parent becomes important.

Dr. Weber's address is Room 230, Davenport Hall, University of Illinois, Urbana, IL 61801. — (By Ben Hardin, SEA, Peoria, Ill.)

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Agrisearch Notes

Precision Egg Planter. An egg planter is a new research tool developed at the Northern Grain Insects Research Laboratory, Brookings, S. Dak. Now, field plots can become uniformly infested with corn rootworms.

Uniform infestations are needed for studying the economic importance of corn rootworms at specific infestation levels, for evaluating soil insecticides, and for screening corn lines for resistance to corn rootworms.

SEA entomologists Gerald R. Sutter and Terry F. Branson developed the innovation for several kinds of research projects. Scientists who study other soil insects also may find the apparatus useful.

The egg planter is mounted on a garden tractor to dispense a liquid suspension of corn rootworm eggs in a furrow made by a chisel plow. The rootworm eggs can be laid down at specified rates by coordinating ground speeds with dispersal of known amounts of liquid containing known numbers of eggs.

The liquid medium is water, slightly thickened with agar to keep the eggs uniformly suspended. The mixture is constantly stirred and the reservoir — made from a 25-liter pressure cooker — is slightly pressurized to further insure even dispersal as the level of liquid drops.

To obtain eggs for their studies, the entomologists collected beetles in August, allowed them to lay eggs in dishes containing soil, and stored the dishes in the laboratory until the following field season. Eggs were then removed from the dishes of soil and suspended in the water and agar.

Sutter and Branson have evaluated the egg planting procedure by examining the amount of damage to corn roots, monitoring the numbers of beetles emerging per plant, and comparing yields of uninfested corn rows with yields of rows containing varying rates of infestation.

The scientific data they obtained can advance research on economic thresholds. An economic threshold is a point at which insect damage reduces crop yield or crop value by the same amount as the cost of applying insecticides.

Dr. Sutter and Dr. Branson are located at the Northern Grain Insects Research Laboratory, Rural Route 3, Brookings, SD 57006. — (By Ben Hardin, SEA, Peoria, Ill.)

Grazing Growth. Recommendations for best grazing management must take into consideration what happens to plants under actual grazing conditions. SEA agronomist Richard H. Hart has developed a simple technique to provide some of the information needed for determining optimum stocking rates.

Optimum stocking rates make a compromise between maximum plant growth and maximum use by grazing animals and eliminates any overgrazing or undergrazing by livestock and wildlife.

Hart photographs individual plants at intervals during the growing season, usually 1 to 2 weeks apart. He also takes photos of ungrazed plants, then clips and weighs these plants. By comparing the photos and knowing how much the clipped plants weighed, he can get an accurate estimate of how many times a plant was grazed, how much of the plant was removed each time it was grazed, how fast it regrew after grazing, and total herbage production for the season.

Until now it has been possible to make only a rough estimate of the amount of herbage removed by grazing. And this method makes no allowance for the fact that plants frequently grazed by livestock or wildlife may grow faster or slower than plants that are protected from grazing.

"So far, with limited sampling, we have found no difference in forage production between grazed and ungrazed tillers of either crested wheatgrass or western wheatgrass in shortgrass range," said Hart. He conducted this study in cooperation with range scientist E. F. Balla, Colorado State University, Fort Collins.

Dr. Hart is at the High Plains Grasslands Research Station, Route 1, Box 698, Cheyenne, WY 82001. — (By Dennis Senft, SEA, Oakland, Calif.)